D1.2 Trends in Connecting Learners

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First Research & Technology Scouting Report

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STELLAR

SEVENTH FRAMEWORK PROGRAMME

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Trends in Connecting Learners

First Research & Technology Scouting Report

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Executive Summary

Technology-enhanced learning (TEL) is an active, interdisciplinary research area in which technologies are developed and applied to support *and* to change current learning practices. The advent of the social Web 2.0 and open-source software is seen to be the main enabling factor for self-directed, collaborative and informal learning practices.

Roadmaps and vision documents serve an important role in shaping the immediate or more distant future of TEL. Various stakeholders have published such documents in the past two years. Research in TEL is carried out in order to reach the envisaged goals; vice versa the goals change due to progress in research. TEL is not just a research area: e-learning takes place at universities, companies and other institutions, as well as at home. These practices are evolving due to the availability and take-up of platforms and tools.

In this first STELLAR trend report we survey the more distant future of TEL, as reflected in the roadmaps; we compare the visions with trends in TEL research and TEL practice. This generic overview is complemented by a number of small-scale studies, which focus on a specific technology, approach or pedagogical model.

The main forecasted technological trends include mobile devices, cloud computing, semantic-aware applications, data mashups, social computing, streaming video, collaboration, personalization and smart objects. Conference topics, research papers and keynote speakers largely confirm these trends. In industry, many of these aspects are covered in 'e-learning 2.0'. Learning management systems are replaced or complemented by popular Web 2.0 services. Personal learning environments – orchestrated mashups of various services – receive attention from both research and industry.

Whereas informal 'e-learning 2.0' is observed to become an acknowledged and outstanding reality, there is no consensus *how* informal 'e-learning 2.0' is expected to change formal learning practices at institutions. This can mainly be traced back to the need for control and assessment. The use of Web 2.0 tools at institutions and increased attention for project-based and scenario-based learning show that the integration of formal and informal learning is already gradually take place.

There are many open issues regarding orchestration and contextualization, which are topics of research. TEL research should provide guidance for these issues *and* monitor how this is done in practice.

1. Introduction

This is the first STELLAR research and technology trend report. This report builds upon and complements the benchmarking of the state-of-the-art as reported in Deliverable D7.1 and the Stellar Vision and Strategy Statement D1.1. The lead theme of this trend report is *connecting learners*, with the underlying research question how self-directed, self-managed and self-maintained communities create successful new forms of collaboration and how these principles can be applied to technology-enhanced learning. From our discussion it becomes apparent that this question is heavily related to the *orchestration* of tools and the *embedment* of informal, collaborative learning practices in the learning process.

In the next chapter we present a survey of trends that can be observed in visions, research and practice around TEL. The main question that we address is to what extent current activities in research and practice reflect the visions created by panels of experts. We discuss trends and research focuses in technology, and the tools and platforms that are currently popular in TEL practice. Particular attention is given to the question how the self-directed, informal learning practices that are facilitated by these tools are expected to change the current system.

To sketch a very diverse picture that gives depth and concrete insights in addition to the generic survey, the STELLAR partners conducted a number of small-scale studies with a very specific focus, to sketch a very diverse picture that gives depth and concrete insights in addition to the generic survey presented in the previous chapter. Another important goal of the studies was to use them as a vehicle for discussion between the STELLAR partners, in order to relate direct experiences to the observed trends in visions, research and practices. In chapter three we summarize the outcomes of the studies and relate them to the trends identified in chapter two.

We conclude this report with a discussion and outlook in chapter four.

2. Survey of trends and connections in TEL roadmaps, research and practice

Technology-enhanced learning (TEL) is an active, interdisciplinary research area. Each year, numerous articles are published at conferences and in journals. TEL research is expected to have a direct impact on the way TEL is applied in practice. Practices and philosophies behind these practices can be extracted from new functionality that is incorporated in learning environments, popularity rankings of tools and the opinion of professionals, as expressed in blogs.

Given the importance of TEL in the educational landscape of Europe, politicians expect a direct impact of TEL research on the TEL practice. At the same time, it is unclear what exactly this impact should be. Various panels of experts from different communities have created roadmaps and visions on what learning will look like – or should look like – in the future.

In this chapter, we discuss the:

- *the more distant future:* current visions for TEL, as reflected in roadmaps (section 2.1)
- *the near future:* current trends in TEL research (section 2.2)
- *the status quo:* current trends in TEL practice (section 2.3)

The main question that we address is to what extent current activities in research and practice reflect the visions created by panels of experts.

2.1 Main Themes from the Roadmaps

Roadmaps and vision documents serve an important role in shaping the immediate or more distant future of research areas, such as technology-enhanced learning. These roadmaps typically reflect the opinions and observations of a wide panel of experts, interpreting and extrapolating current trends.

In the past years a number of roadmaps, foresight reports and other visionary documents on future scenarios for learning and technology have been published by various stakeholders. In this section we discuss the main trends that can be observed from these roadmaps:

- *the Learnovation Foresight Report (2009)*, which is based on a Delphi survey among TEL experts focusing on main factors effecting change of learning systems and priority actions to be undertaken
- *the Educause Horizon Reports 2008 and 2009*, which are based on a panel of more than 250 recognized practitioners and experts in a collaboration between the New Media Consortium and Educause
- *Cisco: Equipping the Learner for the 21st Century (2008)*, an industrial white paper meant to initiate an informed dialogue among education thought leaders and practitioners.
- *Stellar's Vision and Strategy Document D1.1 (2009)*
- *Pew Internet & American Life Project: The Future of the Internet III (2008)*, in which statements of 578 experts are collected.

As will become clear from the following discussion, innovation in technology – in particular the Web 2.0 and social networking are expected to be a major driver for changing the way we learn. Technology is seen as an enabling and supporting factor for learning and developments in this field should be embraced by the teaching and (lifelong) learning communities. Technology is not only an enabling factor: social and collaborative tools are observed to be important motivational factors as well. Inevitably, by embracing new technologies and incorporating them into the system, the character of learning changes. 'Modern' learning is often described as self-directed, lifelong and informal learning. This type of learning, occasionally coined 'Learning 2.0' is regarded as an important new concept, but not necessarily as the one concept that education is heading to.

In the following sections we discuss and interpret findings from the wide panel of experts that created the abovementioned visionary documents. First, we focus on what learning is thought to look like in the 21st century. We continue with a discussion on how technology is regarded as an enabling, motivational and changing factor at the same time. After a listing of which technological developments are expected to have the most impact, we end this section with a discussion on the apparent discrepancy of the informal and self-directed character of Learning 2.0 and the needs of society, which in certain situations can only be met by formal education.

2.1.1 Learning in the 21st century

The meta-trend of globalization is explicitly or implicitly acknowledged in the foresight reports.

Increasing globalization continues to affect the way we work, collaborate and communicate (Horizon 2008)

Is it true that globalization will directly lead to internationalization of learning, with standardized learning solutions and accreditation models? According to Learnovation, the opposite may be true: there seems to be a move towards *differentiation* on various levels. First, now that regions and countries have to compete with one another, it has become even more important to focus on their own strengths, which implies that education should address specific – regionally or culturally determined – goals.

Respondents seem sceptical with regards to a sharp trend taking in 2020 to standardised learning solutions and accreditations models worldwide. Forecasts refer rather to a move towards differentiation, both along local/context-based lines as well as personalization and tailor-made solutions (Learnovation)

This seems to be in contrast with the following trend, as identified in the Horizon report.

The way we work, collaborate, and communicate is evolving as boundaries become more fluid and globalization increases, thanks to the increasing availability of tools to connect learners and scholars all over the world (Horizon 2008)

In fact, as will be discussed in more detail in the last subsection, the differences in opinion most likely signify a difference in goals and ambition between formal education at schools on the one hand and further education in the form of lifelong learning and workplace learning on the other hand. The latter category embraces the learning solutions offered by Web 2.0 technologies and social networking and therewith naturally creates (informal, dynamic) learning communities that may cross regional and national boundaries.

The Cisco report remarks that even though technology has already led to significant improvements in administrative processes at institutes – for example scheduling classes and tracking students – as well as in teaching practices: e.g., digital support and training material, real-time assessment and distance education. However, they continue:

Although these innovations are making a real difference, they are scarcely transformative of teaching and learning.

Collaboration and creativity are already the tools of today's learners and employers and should logically become the tools of today's teachers, schools and education systems as a whole (Cisco).

It may be a matter of time before formal education will adopt teaching approaches that are similar to the approaches adopted by self-directed lifelong learners:

Despite institutional resistance to change, education systems slowly adapt to a changing scenario in which the power of technologies coupled with increased people awareness of the value of education for social mobility press for individual appropriation of the learning experience (Learnovation).

To summarize, it can be observed that:

- Lifelong learning for further education is recognized as an important trend in answer to changes in our society
- Self-directed lifelong learning is broadly interpreted as informal, collaborative learning
- Web 2.0 technologies and social networking are embraced as tools for lifelong learning
- Informal learning is expected to change formal education at schools

2.1.2 Technology as an enabling, motivating and changing factor

According to the Pew Internet & American Life project, currently 97% of all (American) teens and young adults connect to the Internet on a regular basis. A large part of their time is devoted to communication and social networking: 73% of wired American teens and 47% of online adults use social networking sites. The Cisco report confirms these statistics and reports that 'for many learners, class is the only time in their day when they completely disconnect'.

The rapid changes and opportunities brought about by Web 2.0 are increasingly affecting the whole world. Despite these trends, there are limited opportunities to leverage the creative and collaborative capabilities of Web-2.0 technologies in the classroom (Cisco).

The above citation suggests that it is a desirable and natural scenario that collaborative and creative (informal) learning becomes standard practice in formal education. We discuss this in more detail in section 2.1.4. However, it is generally acknowledged that Web 2.0 and communication technology have become an important connecting factor between our work and private lives, which increasingly become intermixed:

The divisions between personal time and work time and between physical and virtual reality will be further erased for everyone who's connected, and the results will be mixed in terms of social relations (Pew)

While factors concerning macro-economic and political scenario, such as political tension and political institutions' perceived legitimacy, are reckoned to have quite a limited impact on the way people learn, those factors closer to the concrete learning activity, such as technology, appear as more relevant.

Technological progress and the rise of social networking are expected to have the highest impact on the way people learn in the future (Learnovation).

The above citation clearly states that changes in the way we learn are the result of a technology push – and not that technology is adopted to facilitate the way we learn, as an answer to changes in society. In other words, social, collaborative learning is gaining momentum, because we adopt technology

that supports this. This statement might be a bit too bold and simplifying, but it clearly shows the importance of technology-enhanced learning as an enabling factor that puts learners rather than teachers at the centre of the learning process:

ICT does not exhaust the whole spectrum of technological bias on learning, though their impact is the greatest one. They are in fact expected to exert an emancipatory power on the individual, thereby contributing to make lifelong learning a natural condition of life and enhancing metacognition of one own learning process (Learnovation).

In a preliminary report on the results of the first STELLAR Delphi Round – which will be published in D1.3 – this effect is effectively characterized:

The individualization of learning is a general trend identified by the STELLAR experts that relates to aspects of several topics. It includes personalized and adaptive learning environments, but also the availability of extensive learning resources for all learners due to open access and the possibility to choose individual learning paths in formal education (STELLAR Delphi Study – Preliminary Report)

2.1.3 Which technologies are expected to have the most impact

The Horizon project annually reviews the main technology trends that will have an impact on learning during the next couple of years. In this section we provide a short overview and discussion of the trends identified in the 2008 and 2009 Horizon reports. We separate the trends in enabling technologies, social technologies and applications.

Enabling technologies

- *Mobile Devices and mobile broadband*

According to Pew/Internet, the mobile device will become the primary connection tool to the Internet. Voice recognition and touch user-interfaces with the Internet will be more prevalent and accepted by 2020. Mobiles are already in use as tools for education on many campuses. Language learners can look up words, practice listening, speaking and writing. Graphical calculators display 3D graphs that can be rotated with a finger on the touch screen. Detailed reference material at hand.

- *Cloud computing*

Educational institutions are beginning to take advantage of ready-made applications hosted on a dynamic cloud to perform tasks that have traditionally required site licensing, installation and maintenance of individual software packages.

- *Semantic-aware applications*

Advances in intelligent searching eclipsed the need for complex metadata schema and laid the foundations for what we called knowledge webs. Ontologies and specifications used for learning include Dublin Core Metadata Initiative, IMS specifications (e.g. LD and LIP) and SCORM.

- *Data mashups*

Wikipedia defines mashups as web pages or applications that combines data or functionality from two or more external sources to create a new services. Mashups are very common on the Internet today, and new authoring tools are being developed that will enable non-technical users to create sophisticated products without programming. *Personal Learning Environments*, built using mashup techniques, become increasingly popular (Gillet and Law, 2010).

Social technologies

- *Collective intelligence*

Wikipedia defines collective intelligence as a shared or group intelligence that emerges from the collaboration and competition of many individuals. Wikipedia itself is an example of collective intelligence: thousands of contributors are continuously and actively engaged in adding, modifying, reviewing and updating them. Collective intelligence also emerges in social bookmarking systems such as Delicious. Tagging and rating mechanisms are common collaborative features on the Web.

- *Social operating systems*

The term 'operating systems' is slightly misleading. It refers to the organization of a (knowledge) network around people rather than around content. The following scenario is given by Horizon:

Imagine the impact of tools that place people and relationships at the center of any research inquiry. A much more complete picture of the topic would emerge. As an example, students reading about Doug Engelbart would see who he has worked with on different projects, giving them a clearer picture of the community of scientists to which he belongs, and the contributions of Engelbart and his peers.

Applications

As will be seen in section 2.3, there are many applications that are currently used in technology-enhanced learning practices. We limit our discussion to the categories listed in the Horizon Reports.

- *Grassroots video*

Streaming video sites, such as YouTube, are currently responsible for the major part of Internet traffic. Online training videos and tutorials have become mainstream. Universities – including the MIT and the OU – have their own, branded institutional channels on YouTube.

- *Collaboration Webs*

Popular online services, such as Google Docs, Twitter, Facebook, Delicious and Skype, are increasingly used for online collaboration.

- *The Personal Web*

The Horizon Report defines the Personal Web as "a collection of technologies that confer the ability to reorganize, configure and manage online content rather than just viewing it". In addition to dedicated Personal Learning Environments, the term includes general sites such as iGoogle that

allow users to create their individual mashup of online applications and information streams.

- *Geo-everything and smart objects*

Both terms refer to technology that can be used 'in the wild'. Location and context awareness informs learners in real-time about nearby resources, points of interests, historical sites, and peers. Smart objects, such as tabletops[1] and objects with sensors or RFID tags, allow for interaction with the learning environment.

2.1.4 Informal learning in Web 2.0 and formal education

Learnovation takes a clear stand when it comes to informal learning – and therewith the use of Web 2.0 technologies, such as collective intelligence and social learning: informal learning is expected to be an acknowledged and outstanding reality, but it will be just one of the models *complementing* formal education.

One of the experts stresses in particular on the impracticability of informal learning as 'the' learning model, due to a perceived irreducible contrast between informal learning features and the needs of a learning society that require a certain degree of formalization (Learnovation)

The STELLAR Vision and Strategy document takes a milder stand:

The interplay between formal and informal learning in formal and informal contexts has to be instrumentalised through the use of physical artefacts, mobile devices and the configuration of physical and virtual space.

Concerns related to informal learning practices in formal learning contexts are manifold, but can mainly be traced back to one issue: the need for control and assessment. Due to the self-organizing character of informal, collaborative learning, it is a challenge for teachers to monitor the learners' progress; the provenance and reliability of information sources is often unclear; quality assurance mechanisms such as assessments and exams are deemed 'not to make sense in informal learning'.

The above arguments can be interpreted as a confirmation of the resistance to change of institutes delivering formal education. This resistance may be well-justified, as learning practices and tools for self-directed, lifelong learning are still subject to rapid development. The Stellar Vision and Strategy document lists several fundamental open issues, including 'what design principles should underpin tools and mechanisms to encourage online participation in communities'.

If it is true that changes in learning practices are mainly driven by a technology push, it is clear that the direction of technology-enhanced learning is toward self-directed, informal, personalized, social, contextualized learning. This direction is given by trends such as mobile devices, mashups, the social and collaborative Web 2.0, rich streaming media, smart objects and sensors.

To what extent this vision can be reached and what it will look like depends on many factors and is a matter of evolution rather than revolution. As a

[1] See STELLAR D3.1 on the Alpine Rendezvous for a more elaborate discussion

result of progress in TEL research and practices, the visions for TEL will change; vice versa it also yields that TEL visions guide TEL research, and that TEL research influences TEL practices. For this reason, we will discuss the current trends in TEL research and practice in the next sections and relate them to the visions, as discussed in this section.

2.2 Main Trends from TEL Research

In the previous section we provided an overview on the current visions on technology-enhanced learning, as expressed by various teams of experts in roadmaps and vision documents. In this section we focus on the question how TEL research is currently working towards these visions.

In order to effectively identify and interpret trends in TEL research, it is important to have an overview of the different research communities within the – arguably fragmented – field of TEL research and the focus of these communities. In section 2.2.1 we summarize the findings of an author co-citation analysis that was carried out to answer this question.

In section 2.2.2 we concentrate on the current research areas that are represented at TEL conferences. Due to the sheer quantity and diversity of conferences and publications, we build upon the benchmarking activities carried out in WP7. In Stellar Deliverable D7.1 – Report on the state of the art in TEL – an extensive overview of trends in TEL conferences was presented in the form of benchmarks. An important focus concerned the shift in research themes in the past decade and fragmentation in the field of TEL research. In section 2.2.2 we summarize and extend the findings.

In section 2.2.3 we provide a short summary of the reflections during the STELLAR Alpine Rendezvous (ARV), which is reported in more detail in the Stellar deliverable D3.1. Main goals of the ARV were to identify and advance emerging topics, methodologies and technologies in the field of TEL research and to build community within and beyond Stellar.

2.2.1 Clusters of TEL researchers and research topics

Technology Enhanced Learning (TEL) is a field with lots of different research questions and aspects to focus on. Many different conferences and journals are devoted to different aspects of technology enhanced learning, providing a variety of forums through which to publish TEL research results.

The downside of this variety is, however, that TEL is a much more fragmented area than most other research areas, making it difficult to gain an overview of recent advances in the field. Even for experienced TEL researchers answering the questions: “What communities and sub-communities can be identified in TEL”, “what research topics/specialties can be identified in a field of studies” and “what conferences are the most relevant for what topic and for which community” is a difficult task, and for beginners it is obviously an impossible one.

Being aware of this fragmentation and of the various sub-communities which make up the TEL area is an important pre-requisite towards overcoming this fragmentation, increasing synergies between different sub-areas and researchers, and, last but not least, providing funding agencies with evidence of new research results, innovative applications and promising new approaches for technology enhanced learning.

As a first step toward this goal, building upon the work by Ochoa et al (2009), we employed Author Co-citation Analysis (ACA) on TEL conferences as indexed by DBLP and CiteseerX. ACA relies on the insight, that if two authors are cited together very often in scientific articles, their work must be

related to the same research field. We analyzed the data using principal component analysis, to detect appropriate thematic clusters in TEL research. In this section we summarize the findings.

Cluster 1: Adaptation and Personalization. The main publication venues of this cluster include Adaptive Hypermedia, Hypertext and ECTEL. From the terms associated with this cluster, a clear focus on adaptive hypermedia systems can be observed. The cluster also includes personalization.

Cluster 2: Artificial Intelligence. Most authors in the second cluster have their roots in the field of artificial intelligence. Whereas the focus of the first cluster is on personalization and adaptation, the second cluster mainly focuses on understanding learners' needs, by applying reasoning techniques to the models of the learner.

Cluster 3: Orchestration and Contextualization. Terms that show up in the third cluster are "Environment", "Mobile", "Pedagogy", "Agent" and "Design". Researchers in this cluster have more diverse backgrounds than in the first two clusters, but with the common denominator that they focus on the application of specific technologies to learning. These focuses include mobile technologies, computer science education and knowledge management.

Cluster 4: Semantic Web and Learning Objects. The fourth cluster is more focused on learning objects than the first cluster. The word clouds of this cluster include "Object", "Semantic", "Repository" and "Metadata". Non-TEL related conferences relevant to information systems and communications as an explicit hint as to how other computer science related areas often influence TEL research.

Cluster 5: Computer Science. The fifth cluster is a very application oriented cluster, with two TEL conferences mostly relating to computer science education and a non-TEL conference on Theoretical Computer Science.

Cluster 6: Learning Design. Researchers in this cluster have contributed to the theory of Learning Design and related technologies and standards, such as SCORM (Dodds 2007).

From these six clusters, the building blocks of the computer-science related research in TEL can be observed as:

- *human-computer interaction*, most prominently (adaptive) hypermedia systems (cluster 1)
- *artificial intelligence* and (reasoning techniques for) user modelling (cluster 2)
- semantics, repositories and metadata (cluster 4)

Cluster 3 and 6 represent the more TEL-specific innovative areas the terms in their word clouds overlap to a large extent with the current research topics in TEL conferences, which will be discussed in the next subsection.

A more elaborate discussion can be found in Appendix 1.[2]

[2] The paper printed in Appendix 1 has been accepted for presentation at EDMEDIA 2010.

2.2.2 Current research topics in TEL conferences

In this section we provide an overview of topics addressed by papers that are submitted to the major TEL conferences in the last two years. For this, we build upon the benchmarking activities reported in D7.1 and extend this with data on the topics and tracks that the conferences address. During conferences, it is common that keynote speakers address provocative and visionary topics, as seen by the research community. At the end of this section we provide an overview of topics addressed in 2009 keynotes.

Conference publications and tracks

In Deliverable D7.1 the most active research topics in TEL, as extracted from the titles of papers submitted to ED-MEDIA and DBLP-listed TEL conferences, were visualized as word clouds, which we list below for reference.

Figure 1: New terms in ED-MEDIA (2000 to 2008)

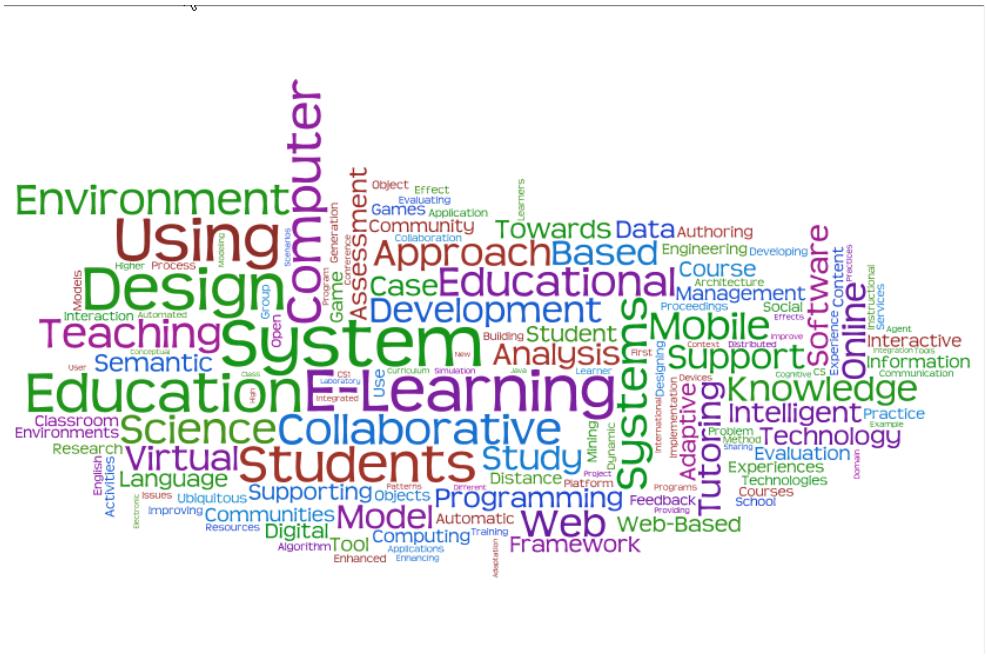

Figure 2: DBLP Conference List Terminology (2008)

As another indicator for the topics addressed at TEL conferences, we collected the topics, tracks and sessions as advertised for the 2009 and/or 2010 editions of the following conferences: ICALT, AIED, Intelligent Tutoring Systems, ICCE, WMTE, Educational Technology & Society, EC-TEL, ICWL, CELDA, DIGITEL, ITiCSE.

The results are displayed in the word cloud below. A comparison with the keywords from the ED-MEDIA and DBLP publications shows that the trends are quite similar. However, some terms that are represented prominently in the tracks are less common in the titles of the publications: game-based (learning), assessment, standards, adaptive.

Figure 3: Tracks and topics extracted from TEL conferences in 2009 and 2010

From an analysis of the keyword clouds and a comparison with earlier years, the following terms were extracted that were either new or had a highly increased importance (related to the six research clusters identified earlier):

- *Adaptation and Personalization:* web-based communities

The Personal Web is listed in the Horizon Report as an emerging technology. Traditionally, personalization stems from the fields of user modelling and adaptive hypermedia. These fields originally focused on models of student interests, goals and background knowledge and personalization strategies based on these models. Currently, the focus is more on collaborative filtering and recommendation in the Web 2.0 – even though 'adaptivity' is still often mentioned in the conference tracks. Interestingly, the emerging trend of Personal Learning Environments and mashups is not (yet) reflected in TEL publications.

- *Artificial Intelligence:* automatic generation

Artificial Intelligence and Data Mining are the main research fields contributing to the field of Web (Usage) Mining, which comprises a broad area of prediction techniques, including Markov Models and Collaborative Filtering. As observed in D7.1, AI techniques do not constitute a main

research area in TEL anymore – however, techniques from this area are still often applied.

- *Orchestration and Contextualization:* blended learning, game-based learning, students learning, knowledge sharing, vocabulary learning, augmented reality, student performance, learning experiences, virtual learning

Not surprisingly, a major focus of TEL research is on application scenarios and evaluation of TEL technology in practice. This is particularly visible in the cloud on new terms in ED-MEDIA, but it can also be observed in the terms extracted from the more technology-oriented DBLP-listed conferences: 'soft' terms include student, using, knowledge, collaborative, language.

In fact, the visibility of terms related to orchestration and contextualization reflects the importance of orchestration and contextualization in TEL in general. A main theme of the roadmaps discussed in the previous section was the role of informal learning in formal learning contexts. As will be discussed in the next chapter – summary of the small-scale studies – game-based learning and other semi-structured learning activities are seen to build the bridge between the two.

- *Semantic Web and Learning Objects:* Web 2.0, semantic web

The Horizon Report listed semantic-aware applications as an emerging enabling technology for technology-enhanced learning. As explained earlier, the Semantic Web has always been one of the core focuses in TEL. This is reflected by the prominence of the term ‘standards’ in the conference tracks.

- *Computer Science:* mobile phone, ubiquitous learning, open source, mobile devices

Mobile devices and mobile broadband are considered emerging technologies in the Horizon report. The high attention for mobile technologies in TEL conferences confirms that researchers recognize this trend. A more elaborate overview of mobile learning can be found in appendix 7 (small-scale study on location-based and contextual mobile learning). Further, many TEL researchers create and use open-source software, which is considered an important enabling factors in the roadmaps.

- *Learning Design:* learning design, learning scenarios, learning activities

The attention for this cluster can be explained in a similar fashion as the attention for orchestration and contextualization.

In summary, it can be observed that TEL conferences mainly focus on technology and how this technology is – or should be – used. There is increased attention for issues related to orchestration and contextualization, as well as for evaluation studies.

Missing emerging technologies from the Horizon report include cloud computing, data mashups and (grassroots) video.

Keynotes at TEL Conferences

As noted before, keynotes during conferences are typically aimed at providing attendees with some provocative and challenging ideas and visions. Below we provide a word cloud, based on the titles of keynotes given at the 2009 editions of various conferences that took place in 2009.

Figure 4: Word Cloud of the 2009 Keynotes at TEL Conferences

From the keywords (rethinking, reinventing, change, perspectives, improve) it can be observed that many keynotes concern envisage changes and innovations in the field. A wide range of topics is addressed in the keynotes, which we list below for reference.

ICALT 2009

- Gerhard Fischer: Cultures of Participation and Social Computing: Rethinking and Reinventing Learning and Education
- D. Michelle Hinn: Video Games and Players with Disabilities: Steps to Better Design for All
- Mohamed Jemni: e-Learning and e-Accessibility, New Trends and New Perspectives
- Patricia Manson: European Research on Technology-enhanced Learning: Current Status and Future Perspectives
- Vladimir Uskov: Advanced e-Learning and e-Training: What is Next?

AIED 2009

- Prof. Susanne P. Lajoie: Can Computers Teach You To Think And Care? The Modeling Debates Revisited
- Prof. Kenneth D. Forbus: Open-domain sketch understanding for AI and Education
- Prof. Wolfgang Nejdl: Exploiting User Generated Content to Improve Search

ICCE 2009

- Riichiro Mizoguchi: What can computers do when they understand learning and instructional theories?
- Gerry Stahl: How I view learning and thinking in CSCL groups
- Agnes Kukulska-Hulme: Learning Cultures on the Move
- Kinshuk: Adaptive and personalized learning experience through mobile technologies

- Nancy Law: Educational Innovations Beyond Technology: sustainable change through nested networks of learning and innovation
- Yong Se Kim: Personalized Learning Support for Creative Design Reasoning
- Jianwei Zhang: Can a Classroom Operate as a Dynamic Creative System?
- Yueh-Min Huang: Research Issues of Web 2.0 on e-Learning

ECTEL 2009

- Peter Pirolli: Making Sense of Sensemaking in the Digital World
- Mike Sharples: Towards an Interdisciplinary Design Science of Learning
- Friedrich W. Hesse: Use and acquisition of externalized knowledge

ICWL 2009

- Prof. Erik Duval: Learning in Times of Abundance: The Snowflake Effect
- Prof. Dr. Wolfgang Nejdl: Exploiting User Generated Content to Improve Search

ITiCSE 2009

- Dr. Claus Brabrand: Analyzing the Competences of (Computer) Science via The SOLO Taxonomy
- Ms. Sally Fincher: Useful Sharing
- Dr. Patrick Porcheron: The Bologna Process in European Education

EDMEDIA 2009

- Heather Kanuka: Why Looking for What Works with E-Learning Isn't Working
- Catherine McLoughlin: Best Practice in E-learning, E-assessment and Learning Environment Design in an Era of Change
- Irina Verenikina: Vygotsky in Twenty-First-Century Research
- Pierre Dillenbourg: Technologies for Orchestration
- Josie Fraser: Making Change Happen: Digital Identities, Digital Learners, Digital Citizens
- Mai Neo: Using Multimedia as an Educational Instrument to Enhance Teaching and Learning Strategies: A Malaysian Perpective
- Alec Couros: Toward Open & Connected Learning: Transforming Pedagogy through Social Networking & New Digital Affordances

2.2.3 Trends at the Alpine Rendezvous

To conclude this section, we discuss a number of relevant trends that were identified during the STELLAR Alpine Rendezvous in December 2009. A main goal of this 'non-standard' conference was to identify and advance emerging topics, methodologies and technologies in TEL.

A common theme of all ARV workshops was the stimulation of collaborative learning. Two workshops addressed technological innovation (mobile devices and tabletops), other workshops addressed application scenarios for these new technologies. A third focus was the interpretation and orchestration of learner actions and events: for example, how to recognize pivotal moments in collaborative learning.

The workshop organizers provided white paper on the outcomes of the workshops. Below we summarize the statements that apply to the issues and trends discussed in the roadmaps from the previous section.

Learning in the 21st century

- there is a trend towards participatory design as an important aspect of creating learning environments; in the future, students should be included and participate in the creation or modification of the system they are meant to work within
- we are currently witnessing a significant shift away from traditional forms of mass communication and editorial push towards user-generated content and individualized communication contexts.

Technology as an enabling, motivating and changing factor

- Mobile and location-based learning allows for separation of 'schooling' (which seems to be assessment-driven) and 'education' (as a more holistic endeavour).
- Will new opportunities for personal and mobile learning prompt a transformation of schooling, or will learning in and beyond school be reconciled without any fundamental change to our education system?
- What is the new role for teachers and learners when old classroom routines are perpetuated with the introduction of new technologies?
- What are contextual boundary conditions that make recommender systems work; how to measure whether learning increased because of the recommended peer learners?
- To what extent do practices around mobile devices influence work-life balance

Informal learning in Web 2.0 and formal education?

- How deep a level of integration of formal and informal learning settings [do] we want?
- How much informal learning within formal learning settings is appropriate and the other way round?
- How can we support a growing *divergence* between formal and informal education (if that exists)?

From the above statements it can be concluded that the ARV participants see 21st century learning as informal, collaborative learning. Apart from Web 2.0 technology, mobile and location-based learning is expected to dramatically change learning from a 'schooling' approach to a more holistic, continuous activity. In particular the last statement is interesting, as it suggests that informal learning practices are rapidly becoming less and less compatible with formal education.

2.3 Main Trends from Practitioners and Industry

In the previous sections we have reviewed the current visions and research activities in technology-enhanced learning. From the reviews it can be observed that there is a consensus that technology – in particular the social Web 2.0 and mobile devices – fosters self-directed, collaborative, informal learning practices. At the same time, there is the feeling that the gap between current institutional formal learning practices and informal learning is growing.

The field of technology-enhanced learning is not limited to the ivory towers of researchers and visionaries: learning management systems (LMSs) – also called virtual learning environments (VLEs) – have since long been in use at educational institutions; several universities offer distance learning and educational video streams; companies offer training programs on their local internets.

In this section we provide an overview of tools and technologies that are currently reported to be in use and the functionalities that they provide. We start our review with the traditional LMSs, which are still widely deployed at universities and other institutions. It can be observed that support for collaboration and communication has become a core feature, in addition to traditional course management support. By contrast, e-learning professionals move away from these 'monolithic systems' and instead adopt their own selections of Web 2.0 services. In section 2.3.2 we provide an overview of the tools and functionalities that are deemed most useful, according to various sources in the 'blogosphere'. In section 2.3.3 we discuss current efforts in research and industry to create mashups of various loose tools in the form of Personal Learning Environments (PLE).

2.3.1 Learning Management Systems

A learning management system (LMS) is a software application for the administration, documentation, tracking, and reporting of training programs, classroom and online events, e-learning programs, and training content. […] LMSs are used by regulated industries (e.g. financial services and biopharma) for compliance training. It is also used by educational institutions to enhance and support classroom teaching and offering courses to a larger population of learners across the globe (Wikipedia)[3]

In the list below the 10 most popular links in the Google Directory, category Course Website Software[4] is given, ordered according to the Google Rank. Note that apart from the well-known LMS systems and two groupware systems, it also lists the academic Ariadne and OKI initiatives.

- *Moodle: a* free, open-source PHP web application for producing modular internet-based courses that supports a modern social constructionist pedagogy.
- *Blackboard:* commercial course website software; can also create a free course on their site.

[3] http://en.wikipedia.org/wiki/Learning_management_system#CITEREFEllis2009

[4] http://www.google.com/Top/Reference/Education/Instructional_Technology/Course_Website_Software/

- *Claroline:* an easy to use, open source software package based on PHP/MySQL.
- *ATutor:* an Open Source Web-based Learning Content Management System (LCMS) designed with accessibility and adaptability in mind.
- *Open Knowledge Initiative:* OKI is an architecture for learning management systems being designed by a consortium of universities and organisations that includes MIT, Stanford and Harvard.
- *ARIADNE Project:* joint European academic consortium. Offers WBT authoring, delivery and management tools. Foundation members have free access to a huge database of reusable course modules.
- *BSWC:* (Basic Smart, Cooperate Worldwide) is a web based collaboration / groupware environment. It is a shared workspace system and supports document upload, event notification, and group management.
- *DotRLN:* An open source e-learning system developed at MIT, based on AOLserver and OpenACS.
- *Angel LMS:* An enterprise course management system that combines an open and flexible architecture with a complete set of easy-to-use features.
- *TopClass:* Web-based training authoring, delivery and management. The authoring environment is entirely Web based.

Other popular learning management systems include Sakai, LAMS and Ilias. A relative newcomer in the field is JoomlaLMS, a commercial LMS that is built upon the open-source content management system Joomla.

Features of LMS

In order to get an overview of common features of LMSs, we carried out an online comparison of six LMS systems[5] from the list above:

- Blackboard Learning System CE 6.1 Enterprise License
- Claroline 1.8.1
- dotLRN/OpenACS
- ANGEL LMS 7.2
- Moodle 1.9
- ATutor 1.6.3

As the features of these systems are subject to change, we only report in how many of these six systems a feature is available.

Communication Tools

- Discussion Forum (all)
- Discussion Management (all)
- File Exchange (all)
- Internal Email (all)
- Online Journal/Notes (all)
- Real-time Chat (all)
- Whiteboard (all)

Productivity Tools

[5] For the comparison, we used http://www.edutools.info/

- Bookmarks (3)
- Calendar/Progress Review (all)
- Searching Within Course (all)
- Work Offline/Synchronize (3)
- Orientation/Help (4)

Student Involvement Tools

- Groupwork (all)
- Community Networking (4)
- Student Portfolios (4)

Course Delivery Tools

- Test Types (all)
- Automated Testing Management (all)
- Automated Testing Support (all)
- Online Marking Tools (4)
- Online Gradebook (5)
- Course Management (2)
- Student Tracking (all)

Apart from these features, it is worthwhile mentioning that all systems are compliant with the instructional standards IMS Content Packaging, IMS QTI and SCORM.

It is interesting to note that the features that originally were the core of learning management systems ('administration, documentation, tracking, and reporting of training programs') are listed in the last instead of the first category (course delivery tools). Instead, much attention is given to communication and collaboration (groupwork, networking, portfolio) functionalities. This reflects changes in the underlying design philosophies, as can also be observed from the companies' Websites:

[Moodle] is a global development project designed to support a social constructionist framework of education.

Claroline is an Open Source eLearning and eWorking platform allowing teachers to build effective online courses and to manage learning and collaborative activities on the web.

Despite the wide spread of LMSs, according to a survey from the MASIE Center[6], 50% of the institutions that use LMSs are not satisfied with their current system; in particular issues concerning reporting options, usability, management, flexibility and interoperability are mentioned.

Further, 50% of the institutions report that they currently use Web 2.0 tools: social networking (74%), Wiki (68%), blog (66%) and chat (47%). This, despite the fact that these functionalities are commonly integrated into the LMSs.

[6] http://masieweb.com/Surveys/learning-systems-survey-results.htm

2.3.2 Tools for E-Learning 2.0

In an often cited article from 2005, Stephen Downes[7] expresses his vision of 'e-learning 2.0', which he conceives as a learner-centred design that is used by digital natives, who syndicate, absorb and share information from multiple sources simultaneously. Social networking sites are used to form communities of practice; learners create their own (multimedia) content in the form of blogs, Wikipedia articles and YouTube videos; e-learning content is not packed into a learning management system, but syndicated and aggregated by students using RSS readers or similar applications; game-based and mobile learning will create opportunities for 'ubiquitous learning'.

Learning and living, it could be said, will eventually merge. The challenge will not be in how to learn, but in how to use learning to create something more, to communicate (Downes, 2005)

Indeed, the rhetoric shares many similarities with the trends and visions discussed in section 2.1. An interesting difference is the strong focus on the *creation and aggregation of content*, whereas the trend in LMSs is mainly towards collaboration and communication through forums, chat and whiteboards.

The Centre for Learning and Performance Technologies (C4LPT) Website[8] provides a list of '25 key tools every learning professional should have in their Toolbox', according to a panel of 278 e-learning professionals – varying from primary school teachers to consultants.

Category		TOP TOOLS
1	**Web browser**	Firefox | Google Chrome
2	**Social bookmarking tool**	Delicious | diigo
3	**Blogging tool**	Wordpress | Blogger
4	**RSS/Feed reader**	Google Reader | Bloglines
5	**Micro- blogging tool**	Twitter | Tweetdeck
6	**Email**	gMail/Google Mail | Outlook
7	**Instant Messaging**	Skype
8	**Personal productivity tool**	Evernote | Google Calendar
9	**Mind mapping**	Freemind | Bubbl.us
10	**Presentation tool**	PowerPoint | Prezi
11	**Presentation sharing tool**	Slideshare | VoiceThread
12	**Online office suite**	Google Docs | Zoho
13	**Web conferencing**	Dimdim | Adobe Connect
14	**Course authoring tool**	Articulate | Lectora
15	**Screen capture**	SnagIt | Jing
16	**Demo/Screencasting tool**	Camtasia | Adobe Captivate | Jing

[7] http://www.elearnmag.org/subpage.cfm?section=articles&article=29-1

[8] http://c4lpt.co.uk/Directory/index.html

17	**Web authoring**	Dreamweaver | Google Sites
18	**Wiki tool**	PBworks | Wikispaces
19	**Image/photo tools**	flickr | Adobe Photoshop
20	**Audio/podcasting tools**	Audacity | iTunes
21	**Video tools**	YouTube | Flip
22	**Personal dashboard**	iGoogle | Netvibes
23	**Course management system**	Firefox | Google Chrome
24	**Social networking**	Delicious | diigo
25	**Integrated social media platform**	Wordpress | Blogger

Most of the categories are related to *productivity*: the creation of content in different forms – blogging and microblogging, presentations, screencasts, office suites, course authoring, Web authoring, Wiki, images, audio and video. A second major category is *communication and networking*: social bookmarking, email, instant messaging, Web conferencing, social networking and social media. The third category comprises *personal management tools*: calendar, mind mapping and personal dashboards.

The C4LPT also provides a ranked list of the tools[9]. Some interesting observations can be made from this top 10:

1. Twitter – Microblogging tool
2. Delicious – Social Bookmarking Tool
3. YouTube – Video Sharing Site
4. Google Reader – RSS Reader
5. Google Docs – Office Suite
6. Wordpress – Blogging Tool
7. Slideshare – Hosting Presentations
8. Google Search – Web Search Tool
9. Audacity – Sound Editor and Recorder
10. Firefox – Web Browser and Extensions

First, none of the tools is specifically designed for learning. Rather, they seem to support organizing learning: planning of activities, communication, creation, sharing and search. The only learning (management) system in the top-30 is Moodle at rank 12 – even below the Audacity Sound Editor and Recorder.

Second, even though the Top 100 Tools for Learning 2009 has been compiled based on a panel of 278 learning professionals, the list is far from stable. For example, Twitter has made an enormous jump from rank 43 in 2007 to rank 1 in 2009; Slideshare jumped from rank 31 to rank 7. By contrast, Skype dropped from rank 3 in 2007 to a shared rank 11 in 2009.

[9] http://c4lpt.co.uk/recommended/top10tools.html

2.3.3 Personal Learning Environments

Personal Learning Environments are systems that help learners take control of and manage their own learning. […] A PLE may be composed of one or more subsystems: As such it may be a desktop application, or composed of one or more web-based services (Wikipedia)[10]

From the last two subsections it has become clear that traditional learning management systems are often complemented by popular Web 2.0 tools. Following the Web 2.0 of combining various tools in a mashup.

Important concepts of PLEs include the integration of both formal and informal learning into a single experience, the use of social networks that can cross institutional boundaries, and the use of networking protocols to connect a range of resources and systems within a personally-managed space.

The field of Personal Learning Environments is an active field of research that has gained attention from industry. The EU FP7 ROLE project investigates the interplay between personal learning and personal learning environments (Gillet et al, 2010). In 2009 the EU FP7 Project TENCompetence released the Personal Competence Manager, aimed to support lifelong learning[11].

In industry, the open source social network platform Elgg[12] is often mentioned:

Elgg is social networking software designed especially for education - built from the ground up to support learning. […] Elgg differs from a regular weblog or a commercial social network in the degree of control each user is given over who can access their content (ReadWriteWeb)[13]

2.3.4 Summary

In this section we provided an overview on developments and trends in learning management systems and Web 2.0 tools that are used for learning. While learning management systems are becoming more 'social', e-learning professionals as well as educational institutions adopt a wide range of Web 2.0 as well – as an alternative or complement to monolithic, closed LMSs. There is an increased interest in platforms and approaches for combining the different tools in mashup applications.

[10] http://en.wikipedia.org/wiki/History_of_personal_learning_environments

[11] http://www.tencompetence.org

[12] http://elgg.org/

[13] http://www.readwriteweb.com/archives/e-learning_20_all_you_need_to_know.php

3. Reports on Small-Scale Studies

Starting from August 2009, the STELLAR partners conducted a number of small-scale studies with a very specific focus, to sketch a very diverse picture that gives depth and concrete insights in addition to the generic survey presented in the previous chapter.

Each study would analyse the current state of the art in a certain field or reflect on recent project results. The studies should provide insight in:

- how a certain technology, approach or pedagogical model is currently being used or developed,
- its maturity, strengths and weaknesses
- issues that should need to be addressed in future work

To give the study a specific focus, the title should comprise a topic (e.g. lifelong learning, eGaming, online teamwork) and a target group or context (e.g. self-employed, higher education). There should be a focus on 'connecting learners' (but that is still a broad area).

For the study the partners could decide to build upon results of running or recently finished projects, or to conduct a short-term cooperation with partners; the study should be integrated with current TEL research or stakeholders.

The studies have been selected after internal discussions among the partners during the Stellar Roadmapping Meeting in Bristol, several FlashMeetings and one-to-one conversations. Further, the setup of these studies and how they will succeed in providing a coherent view of the state-of-the-art has been analyzed by an internal reviewer.

The results of the studies are bundled as white-paper annexes to this deliverable and have been or will be published at peer-reviewed journals, conferences and workshops. In an online meeting, the study results were presented to one another, followed by a discussion on to what extent the conclusions and challenges derived from the study can be related to each other, to the trends as reported in the earlier chapter and to the Stellar Grand Challenges.

In the next section we summarize the aims, setup and conclusions of the studies. In section 3.2 we relate the studies to each other, to the reported trends and the Grand Challenges. Following the conclusions in section 3.3, we conclude this chapter with more elaborate summaries of the studies, including references to the appendices.

3.1 Description and Summary of the Studies

Small-scale studies are short projects, carried out by the Stellar partners - in some cases in cooperation with external partners. The aim of these studies is to provide insight in the current state-of-the-art in a specific field.

Study 1: Social Annotation for Collaborative Learning and Knowledge Management (L3S)

This study involved a set of experiments focused on the role of annotations in various user contexts. One study compared traditional paper-based annotations with online annotation. Other studies focused on how online annotations are created and used for sharing and re-finding. From current practices design guidelines and pointers for future improvements of annotation systems and social bookmarking systems in order to better support informal learning practices and knowledge exchanged have been extracted.

Study 2: Methodologies for the Design of Structured CSCL (ITD-CNR, LMU)

This focus of this study is which type of guidance – scripting – of collaboration in formal learning situations performs best in terms of engagement and outcomes. Macro-level scripting involves general setups like discussions, role plays and case studies, and provides learners much freedom to take decisions themselves. Micro-level scripting directly influences the collaboration: which activities should take place at what time. From the results it becomes clear that the former approach is more useful for adult learners with a good degree of self-regulation; micro-level scripting works better for younger students with more need for support. More experiences and theoretical background is needed for finding suitable blends of these approaches.

Study 3: Discovering Micro-Practices of Knowledge-Workers (KMRC, KC)

In this study informal knowledge building and sharing via collaborative construction of wiki-articles was analyzed. The main question was which indicators can be identified for measuring the maturity of a text. Several types of editing events have been identified that have sufficient predictive power; a small number of events yielded an identification rate of 80%. The possibility to predict the maturity of a text from accommodation processes opens various possibilities for creating tools to support knowledge maturing.

Study 4: eGaming in Higher Education (UJF)

Computer simulations afford the possibility of experiencing a phenomenon when it is impractical to confront learners with such a phenomenon in the physical world. An example situation is communication with patients. In this study it was investigated to what extent the realism – authenticity – of the actors in the simulation influences learner engagement. From the results it can be concluded that apart from the realism of the actors, the coherence of a simulation or game and its relevance to learning goals is important. This implies that realism can be sacrificed for didactical purposes.

Study 5: Technologies for Classroom Orchestration (EPFL)

Teaching methods are often evaluated by the learning outcomes. Equally important are issues such as teacher and student workload, reusability of material and learner engagement. With a suitable orchestration, teachers feel that the method is ‘working well’. In this study experiences with three examples of technologies in class-room situations are reported. Orchestration in the class-room is – in contrast to physical or online education – based on face-to-face communication, depend on the spatial layout of the environment and require flexibility. Further, in almost all learning situations one has to deal with legacy processes and tools. It is a challenge

to translate successful uses and evaluations of tools in one situation into general approaches.

Study 6: Location-based and contextual mobile learning (UNOTT, OUNL)

In this study a literature review and a concept mapping study at the Alpine Rendezvous have been summarized in a survey on contextualized mobile learning for new researchers in the field. The report addresses our central research questions of how can we investigate, theorise, model and support contextual learning within and across location.

Study 7: The role of social software and social media in educational intervention and transformation (CSI)

The various practices around social media are a promising field of experimentation in constructing methods for self-directed learning in higher education settings. In a Master's level course students were collaborating from the distance, making use of a variety of networked tools and services, such as MSN and Skype. The results show that students experienced several challenges in organizing their self-directed learning, in evaluating it against expectations on own initiative, responsibility and assignments, and in making use of the (common Web 2.0) tools. Despite the perceived benefits of the approach, students wished more supervision and practice for using social media. The results imply that not only a transition process from formal learning at schools and universities to self-directed learning in practice needs to be developed, but also that adult education should take dispositions for self-directing intentional learning projects into account.

3.2 Discussion

From the above descriptions of the studies it can be observed that three studies (1, 3 and 6) explicitly focused on technologies for self-directed and contextualized learning. These studies, focusing on mobile learning on the one hand and collaborative Web 2.0 practices – creation and sharing of annotations, collaborative document editing, show that *practices for the use of these tools exist and that their usage can be assessed to a certain extent* in terms of outcomes. However, the practices have not been adopted as a 'teaching method' and evaluated as such.

By contrast, studies 2 and 5, focus on the use of collaborative scripts and supportive techniques for group-based or classroom learning. These scripts and techniques have been specifically designed for formal learning situations and shown to be particularly useful in specific learning contexts. In study 5, evaluation criteria of teaching methods using these techniques have been summarized as 'it works well': apart from learning outcomes, the method should meet certain other criteria, such as required workload, potential for reuse, student satisfaction and suitability for the specific room and group size. Both studies show that it is *hard to generalize the outcomes* of the studies to significantly other learning contexts.

In study 4 and 7 it has been investigated how episodes of self-directed informal learning can be integrated into formal curricula. In study 4, students were collaborating in online simulations and in study 7 students were

collaborating using social media. In both studies, the students' *need for guidance and feedback* during the interaction were mentioned.

Between the studies a contrast in approach can be observed. The studies on informal learning practices mainly follow a technology-push approach: given a certain technology and associated use of this technology, how is it used and how could this be beneficial for learning. The latter two categories of studies start from existing learning practices and try to improve these practices by selectively applying chosen technological means – a pedagogy-push approach. At the same time, all studies aim to answer the same conceptual question for different configurations of technologies and learning aims: does this envisaged or established method (making use of a specific technology) 'work well' in one or more specific settings.

We frequently encountered the issue of lack of generalizability, which led to a fundamental question: *do we actually have a good idea on the foundations of learning, of which we try to intervene with technology?*

Further, all studies started from a method or technology that was aimed to *change* a current situation and to evaluate the results of these changes. Many effects observed during the studies may be the result of unfamiliarity with the new method and a resistance to change - for example as observed in study 7 – is a natural effect. A natural tendency of researchers is to 'take shortcuts' in their evaluation, by designing a learning context that is positively skewed toward the method that they are investigating (Greenberg & Buxton, 2008). Unfortunately, *there are not sufficient long-scale studies that provide sufficient material for a fair and critical comparison*.

A large part of the discussion session was devoted to the apparent contrast between formal learning at schools and informal learning practices in lifelong education – a contrast that can be observed from the small-scale studies as well. Even though definite answers are beyond the scope of this trend report, it is certainly useful to discuss the different viewpoints and insights.

The CSI representative (study 7) stated that our current schooling approach – in which someone (the teacher) takes all major decisions on what to learn, how to learn and when to learn – does not relate at all to the way people work. Even though learners at a younger age do need the guidance offered by formal learning, *it does not make sense to carry this system up to University or even PhD level*.

It is clear that one needs to learn how to use specific techniques and approaches. For this, a clear structuring of activities and active guidance is needed. The idea of structuring collaboration activities using scripts – as investigated in study 2 – helps the learner to learn how collaboration works and to gain confidence. One also needs to take into account that *structure has several dimensions* – time, tasks and teams – and that different gradations of structuring can be applied to each of these dimensions. Structuring and guidance of collaboration is essential in lifelong learning as well. Without regular impulses, such as deadlines or reminders, online collaboration is doomed to end up in inactivity.

Project-based work and scenario- or game-based learning are examples of how informal, collaborative learning can be integrated into formal curricula.

For each of these activities, one can set the end goals and assessment criteria beforehand, as well as some interim milestones.

Transition period between formal and informal learning is already done through project-based work and scenario/game-based learning. End goals and some interim milestones can be set beforehand, with formal assessment criteria.

The choice to what extent learning activities should be structured or guided does not only depend on the effectiveness, but also on the efficiency. Proponents of formal learning approaches often claim that structuring is needed for acquiring 'deep factual knowledge' in the limited time given by the educational systems. Proponents of informal, self-directed learning point out that learners need the opportunity to make failures and to learn from them. Even though this is not a new or surprising notion, its implication is often neglected in TEL research: *before introducing new technology and/or methodologies, one needs to determine first which (meta-)competences the learner is supposed to acquire. Then the room for failure or the need for control is a matter of balancing.*

There are no definite answers to the above questions. During the discussion session, it was stated that 'education is a human affair, not a natural phenomenon'.

3.3 Conclusions and Reflection

The small-scale studies were envisaged as an activity that should provide more detailed insights on specific aspects of technology-enhanced learning. We expected the studies to provide answers to the following questions, regarding a particular technology or approach in a certain learning context:

- how a certain technology, approach or pedagogical model is currently being used or developed,
- its maturity, strengths and weaknesses
- issues that should need to be addressed in future work

In this chapter an overview of the study results has been described; more details can be found in the appendices of this deliverable. Another important goal of the studies was to use them as a vehicle for discussion between the STELLAR partners, in order to relate direct experiences to the observed trends in visions, research and practices. The studies have also turned out to be an effective instrument in identifying differences in backgrounds and research focus within the STELLAR community.

As the name indicates, the small-scale studies were envisaged as focused efforts to identify trends in TEL practice. In addition, the studies were aimed to provide opportunities for collaboration between STELLAR partners and to stimulate research in the network in an early stage of the project. Three of the studies have led to a fruitful collaboration between partners. Still, it is clear that the studies are rather self-contained. In the meantime, larger efforts have been carried out to stimulate research and collaboration within and beyond STELLAR as part of the WP3 Research Capacity and WP4 Next Generation Capacity activities. At the moment of writing, the proposals for

the WP3 Theme Themes and Incubators are being evaluated and grants for the WP4 Doctoral Mobility Program have been provided to Ph.D. students with a focus on TEL.

3.4 Summaries of the Small-Scale Studies

3.4.1 Study 1: Creation and Use of Annotations in Different Usage Contexts

Stellar Partners involved: L3S

Contributors: Eelco Herder, George Papadakis, Ricardo Kawase, Wolfgang Nejdl

Type of Study: User Study

Abstract

It is virtually impossible to think of a world without annotations. People write comments in paper margins and highlight text passages; they write reminders on post-its and put short messages on colleagues' desks. Though widespread in everyday life, these kinds of annotations are far less common in the digital world, notwithstanding the availability of several tools to do so.

Creating annotations supports the learning process in paper-based situations. However, when it comes to online learning, annotation becomes an additional burden, due to the lack of suitable tools and intrinsic problems related to reading from a screen and interacting via keyboard and mouse.

We present a series of user studies on various aspects of user practices and goals for paper-based and digital annotation. The results confirm that digital annotation practices effectively support sharing, organizing and re-finding – in similar ways as social bookmarking systems. However, they fail in providing support for annotating for comprehension.

Annotation systems must be flexible to support a wide range user needs and user contexts. However, similar to the paper-based world, users will most likely only annotate when there is the need to do so or when it provides certain benefits. Annotating might not become a mainstream activity on the Web, but users should have the means to do so, when they want or need to.

Take-Home Messages

- *Design for thinking*: annotation tools should provide intuitive tools for marking text and writing notes in the margin – even if these annotations may not be that useful in searches for re-finding as tags would be.
- *Design for re-finding*: annotation systems should provide the means not just to attach annotations to a page, but to visually relate them to a particular fragment
- *Design for ease-of-use*: attaching annotations to the content and means for highlighting text passages in such a way that it becomes a natural activity while reading.
- *Design for sharing*. Writing for the benefit of someone else is different from writing private texts and therefore these two should not be mixed.

(see Annex 2)

3.4.2 Study 2: Methodologies for the Design of Structured CSCL

Stellar Partners involved: ITD-CNR, LMU

Contributors: F. Pozzi, D. Persico, F. Fischer, L. Hofmann

Type of Study: Literature search + Multiple case study

Abstract

One of the most challenging fields in the TEL research area, is the one devoted to the study of the learning processes, when they occur in online environments, especially if they are based on collaborative activities. In this research thread, the debate around the use of structured activities to support interactions and collaboration among peers is quite lively.

To what extent it is useful to provide students with step-by-step instructions so to guide their interactions? Does this really help them to accomplish the task, or does this hinder collaboration?

The study discusses a German and an Italian research experience, where different approaches are used (macro and micro design approach): while in the former context, students are very strictly guided thanks to scripts, in the latter one there is more flexibility, even if different techniques are adopted to provide more or less structure to the proposed activities. This study discusses and compares the strengths and weaknesses of the two design approaches. What can we learn from the two experiences? Is there any possibility – and with what advantages – to integrate the two approaches, so to gain from both?

Take-Home Messages

- Structuring activities at a macro level lets a wider margin of freedom to both students, whose interactions are not completely guided even when the activities are highly structured, and tutors, who may intervene and tune the micro-design of the activities at run time, by providing stimuli to enhance those dimensions of the process that result to be weak.
- The use of scripts at micro design level allows a more structured process, where there is little chance for the students to be “disoriented” by the task and where the tutor’s contribution (and effort) is limited (if any).
- The choice between the two usually depends on the target population to address, the learning objectives, the contexts, etc. But is there any possibility to contaminate the two approaches? To what extent is it possible to take the best from each of them? Does this new, integrated approach would improve the collaborative learning process?

(see Annex 3)

3.4.3 Study 3: Discovering Micro-Practices of Knowledge-Workers

Partners involved KMRC, KC

Contributors: Stefanie N. Lindstaedt, Ulrike Cress, Andreas S. Rath, Johannes Moskaliuk Nicolas Weber Joachim Kimmerle Didier Devaurs

Abstract

When people use wikis to work jointly on shared digital artefacts, this may lead to the collaborative creation of new knowledge. The consideration of the digital products and the insights into the construction process itself may lead to a better understanding of knowledge-building processes. In turn, this understanding of knowledge building may help to design environments that support the improvement of knowledge building. Therefore, the central research question for our paper is twofold: on the one hand it identifies indicators for knowledge maturity; on the other hand it provides some considerations on how knowledge maturing may be supported.

Starting from a premature first version, the final article is assumed to be more correct and stable. In a cooperation study of researchers from psychology (KMRC in Tuebingen) and information science (Knowledge Center in Graz) we wanted to find out whether it is possible to identify the maturity of an article. Results show that it is hard for people to estimate themselves the impact of the changes that they applied. It was the aim of the study to search for an algorithm which can detect and quantify knowledge automatically.

In order to provide answers to these questions, we conducted a study in which participants had to work with a wiki-text with the instruction to improve the text and add further arguments. On the basis of the users' behaviour, we developed an ontology-based task detection approach that identified knowledge maturing processes with a rate of 79.12% (the findings of the tool were gauged with the ratings of two experts who evaluated people's actions with regard to knowledge maturing). The findings are discussed against the background of the question on how it can be ensured that knowledge workers contribute to the development of knowledge.

Take-Home Messages

- Collective knowledge maturing can be quantified.
- Web 2.0 makes the creation of knowledge more probable.
- Working with wikis enhances a group's efficiency.
- Organizations should be able to automatically access the maturing process of their knowledge.
- The best way to create new knowledge is to let people work with a shared artifact.
- Knowledge sharing is not enough; organizations must support collaborative knowledge construction. Wikis can support this.
- The knowledge maturing process of a text can be assessed by analyzing how a person interacts with this text.

- Indicators based on contextual data can help automatically assessing the maturity level of a knowledge artefact.
- Understanding how knowledge artefacts mature helps providing support for knowledge creation.
- Whereas "high-level" environmental and cultural context provides a ground for personalizing the learning experience, "low-level" interaction context generated by the learner's experience provides a ground for reflecting on the learning experience.

(See Annex 4)

3.4.4 Study 4: EGaming in Higher education

Stellar Partners Involved: UJF

Contributors Muriel Ney, Celso Gonçalves, Nicolas Blacheff, Claudine Schwartz, Jean-Luc Bosson

Abstract

A key concern in game-based learning is the level of authenticity that the game requires in order to have an accurate match of what the learners can expect in the real world with what they need to learn. In this paper, we show how four challenges to the designer of authentic games have been addressed in a game for an undergraduate course in a medical school.

Learning games are fascinating tools to promote learning and game authenticity impels students to engage in activities. One way to create authenticity in learning games is immersion, which means making learners feel like a certain situation is real although they know it is not.

We focus on immersion in an authentic situation of interaction. More specifically, students' interact with realistic and engaging characters through phone messages, mail messages, SMS and videos. Two questions come up in this context: how to design an authentic game? Is the game perceived as authentic by the students?

We propose answers to these questions in a game for a medical school undergraduate course. First, we analyze the game authenticity through four attributes: authenticity of characters, feedback content, communication mode and channel, and constraints. Second, we define students' perceived authenticity through three dimensions: external authenticity (perceived likeness with a real life reference), internal authenticity (perceived internal coherence of the proposed situations), and didactical authenticity (perceived relevance with respect to learning goals).

Take-Home Messages

- Computer simulations help learners to become more confident in handling real-life situations
- One needs to find a balance between authenticity of the situation and the pedagogical aspects of the learning context
- Monitoring of the progress should be part of the simulation
- Learner engagement depends on the authenticity of the game, as well as on its internal coherence and relevance from a learning perspective

(see Annex 5)

3.4.5 Study 5: Technologies for Classroom Orchestration

Stellar Partners involved:	EPFL
Contributors:	P. Dillenbourg, P. Jermann & G. Zufferey
Type of Study:	Field Study

Abstract

This study will focus on the physicality of classroom orchestration. Our research question is: how do teachers integrate paper sheets in their design of class activities? Our method is design-based research: we will work with the teachers over the summer to develop activities which will be tested in the fall.

What do we mean by "orchestration"? Metaphors are rather popular in education but do they convey any new pedagogical idea? To address this question, we decomposed the different factors that could differentiate "orchestration" technologies from other educational approaches. They key factor is that they empower the teacher in his role, not as a lecturer, but as the driver of multiple learning activities. Despite all discourses on the role of teachers, many technologies tend to push them on the side. In this approach the teacher plays her role, not as the ultimate source of knowledge, but as the leader of the activities. His coordination task is described as "orchestration" because of the integration of multiple levels of learning activities: individual work, small group activities and class-wide activities (lectures, debriefing,...).

Our understanding of "orchestration" is hence quite specific, focused on school-based learning and mostly on in presence activities. We illustrate with a few examples that this approach has actual consequences on the computational choices for implementing learning environments.

Take-Home Messages

- *Constructivism does not mean teacherless.* The slogan "from the sage on the stage to the guide on the side" has been an oversimplification. The teacher has a unique and central role in setting learning activities.
- *Don't forget schools*. While our community is passionate about informal learning and new social networks, daily life is still based on the fact that kids learn the hard things at school. Improving the effectiveness of school learning should remain the first priority of TEL.
- *We are not virtual*. While TEL has focused on virtual environments, a new trend is to design physical artefacts for face-to-face collaboration. The concrete affordances of tangible objects, the physical layout of the teaching rooms and the physical design of computational artefacts actually play a key role in the success of a learning environment

(see Annex 6)

3.4.6 Study 6: Location-based and contextual mobile learning

Stellar Partners involved:	UNOTT & OUNL
Contributors:	Elizabeth Brown, Mike Sharples, Caroline Windrum (UNOTT), Marcus Specht, Dirk Boerner, Christian Glahn (OUNL)
Type of Study:	Literature review and case studies involving a workshop

Abstract

This study synthesises and extends material that the partners have collected from previous and current running research projects and a workshop organised at the STELLAR Alpine Rendezvous 2010 related to location-based and contextual mobile learning. The study comprises three phases: first, the partners conducted a literature review and analysis of existing systems; second, mobile learning experts were recruited to a concept mapping study to identify the main challenges that can be solved via mobile learning; third, we identified educational patterns based on these examples and challenges. Out of this study the partners aim to develop an educational framework for contextual learning as a unifying approach in the field. The report addresses our central research questions of how can we investigate, theorise, model and support contextual learning within and across location.

Take-Home Messages

- location-based learning will become more popular in the next few years
- recent and ongoing technological developments mean that opportunities for informal mobile learning on-the-go will increase
- contexts of learners can change in many ways, across time and location (in addition to that of task/goal)
- learning contexts are created through interactions between learners, technologies, settings and resources
- we need to understand and model how location can be exploited to create effective and enjoyable experiences of formal and informal learning

(see Annex 7)

3.4.7 Study 7: The role of social software and social media in educational intervention and transformation

Stellar partners involved:	CSI
Contributors:	Sebastian Fiedler
Type of study:	Re-analysis and re-interpretation of intervention studies & literature review

Abstract

In recent years social media and social software tools and practices have been applied in numerous implementation and pilot studies in higher education. Some of these studies have been driven by explicit educational goals (such as fostering community involvement in learning and teaching; peer learning; competence advancement in collaborating, social-networking, and self-directing; social and collaborative production, and so forth). On the other hand numerous implementations seem to have been mostly inspired by the attractive, technical flexibility of an emerging decentralized landscape of loosely-coupled, networked tools and services and its alleged potential for changing the dominant patterns of institutional provision of ICT in education. Some have noted that these implementations produce more questions than answers. It is becoming clear that greater depth of examination is required to clarify what type of educational change goals and what type of systemic interventions can actually be supported effectively by bringing social media practices into higher education.

Furthermore, exploration is needed of the tensions, barriers and unintended consequences that are likely to result from educational interventions that try to use such practices as a significant "leverage point for change" in higher education. However, the change promised by new technologies often represents a Faustian bargain. Increased understanding of the unintended consequences of change is imperative if intervention focuses not only on first-order change by making mere "incremental improvements within existing modes of practice", but strives for second-order (or radical) change) involving a fundamental shift in how things are done within the targeted context. Change agents need to understand if and how a strategic change made in one part of the system influences (or fails to influence) other parts of the system. What actors are (or ought to be) included in an intervention is another important issue here. Foster-Fishman, Nowell, & Yang (2007) remind us that "… if the boundaries are drawn too wide, then the systems change effort can become cumbersome and unmanageable; if drawn too narrow then vital system pieces may be ignored". The way a system is bounded places limits on our understanding and our ability to leverage change. This is where many technology driven interventions in education seem to fail. While re-mediation efforts based on the introduction of new technological tools often trigger temporary changes in practice, "this emphasis on instrumental re-mediation often entailed a relative neglect of corresponding transformations in the division of labour, community and rules – that is, the social-organizational re-mediation of the activity system"

Since social media practices tend to fundamentally alter the traditional configurations of responsibility and control of instructional functions that characterize settings in formal higher education, these changes always effect other parts of the overall system such as norms (beliefs, values, attitudes, orientations), resources and regulations (policies, procedures, routines). A common example of these phenomena is the misfit of the production modes mediated by social software (co-production, multi-authorship, etc.) and their typical products (networked artefacts) with the assessment norms and procedures of the overall institutional system.

Take-Home Messages

- Informal learning requires learners to take initiative and responsibility for their own learning. This is something that has to be learned as well.
- Learners typically do not encounter problems in choosing the right tools and services for collaborative work; still, synchronization of work and creating common understanding is difficult and time-consuming.
- Too much freedom and lack of structure can create chaos, which hinders the learning process. Supervision and effective feedback mechanisms are extremely important in informal learning.
- Self-directed learning projects are essential to learn the skills for coping with many (educational) challenges in today's increasingly networked and mediated working life.

(see Annex 8)

4. Summary and Discussion

In this first STELLAR trend report we surveyed the more distant future of TEL, as reflected in the roadmaps; we compare the visions with trends in TEL research and TEL practice. This generic overview is complemented by a number of small-scale studies, which focus on a specific technology, approach or pedagogical model.

The main forecasted technological trends include mobile devices, cloud computing, semantic-aware applications, data mashups, social computing, streaming video, collaboration, personalization and smart objects. Conference topics, research papers and keynote speakers largely confirm these trends. In industry, many of these aspects are covered in 'e-learning 2.0'. Learning management systems are replaced or complemented by popular Web 2.0 services. Personal learning environments – orchestrated mashups of various services – receive attention from both research and industry.

Whereas informal 'e-learning 2.0' is observed to become an acknowledged and outstanding reality, there is no consensus *how* informal 'e-learning 2.0' is expected to change formal learning practices at institutions. This can mainly be traced back to the need for control and assessment. The use of Web 2.0 tools at institutions and increased attention for project-based and scenario-based learning show that the integration of formal and informal learning is already gradually take place.

The lead theme of this trend report is *connecting learners*, with the underlying research question how self-directed, self-managed and self-maintained communities create successful new forms of collaboration and how these principles can be applied to technology-enhanced learning. From our discussion it becomes apparent that this question is heavily related to the *orchestration* of tools and the *embedment* of informal, collaborative learning practices in the learning process.

There is a wide variety of common Web 2.0 tools for content production and consumption, communication and networking, and personal management available, which are embraced by e-learning professionals and – to a lesser extent – by educational institutions. The attention for personal learning environments and social platforms such as Elgg show that progress is being made at this point.

Several of the small-case studies have shown how scripting, game-based learning and project-based work are effective in embedding these practices in the learning process. Still, the evidence is limited to the specific contexts in which the studies were carried out. It is felt that more long-scale studies are needed for providing sufficient generalizable evidence.

In Deliverable D1.1 several recommendations for the research and development strategy for STELLAR have been given on how STELLAR instruments can contribute to the Grand Challenges – including ongoing debates in podcasts, involvement of stakeholders and discussion at the

Alpine Rendezvous. This trend report identified several trends and issues for further research that should flow into the debates and future STELLAR research activities – theme teams, incubators and doctoral mobility program.

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In addition to the references listed below, several references to online resources are incorporated as footnotes.

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